Synthesis and Processing of Novel Materials

Capabilities/Facilities

Conventional laboratory scale powder handling, hot-pressing and sintering, and thermal spray capability, and solid state combustion synthesis. Large scale high temperature vacuum induction furnace (85° liters and 1700°C) capable of handling uranium; remotely-contained hot-isostatic press capable of processing irradiated materials, fission products, and actinides (U, Pu, Am, Np, Cm, Th); and sintering furnace in-cell. Cold-wall induction melter for rapid melting of materials, and several glovebox furnaces and arc melters that are capable of handling U, Pu, and minor actinides.

Materials

Neutron-absorbing materials, functional gradient materials, fuel cell materials, steel, zirconium, uranium, plutonium, minor actinides, ceramics, nanoscale materials, and fission products, and intermetallics (NiAl, Ni3Al, TiAl).

Scientific/Engineering Issues

Synthesis of novel functional materials (e.g., controlled conductivity, graded elastic modulus); sample preparation for microstructural, mechanical, and properties characterization of radioactive materials; plasma synthesis of nano-sized Ti and complex ceramics; plasma synthesis of hydrides; near-net and net-shape spray forming of engineering alloys.

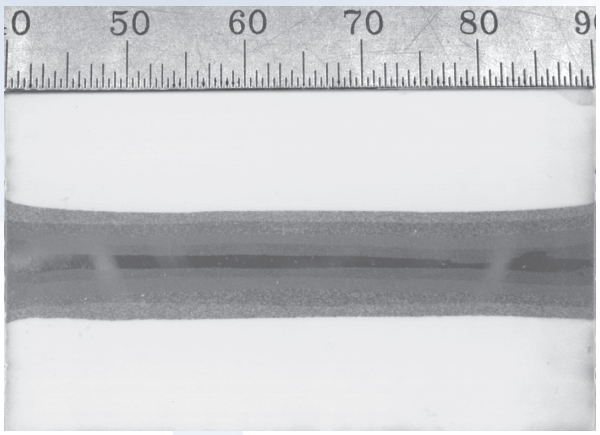
Staff

K.J. Bateman, K. Marsden, W.E. Windes, P.A. Lessing, R.E. Mizia, P.C. Kong, B.A. Detering, L.D. Zuck, K.M. McHugh, G.A. Moore, J. Stuart, I. Glagolenko, J.R. Kennedy, K. Carney, C. Clark, M.K. Meyer.

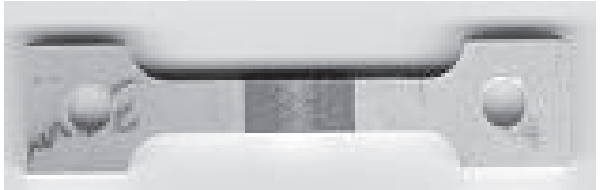
Recent Projects

- Neutron absorber materials for Yucca Mountain
- Fabrication and characterization of dual-phase MgO-based ceramics for use as an inert fuel matrix
- Equipment used to support several ongoing projects, including fabrication of uranium-bearing waste forms, RTG power sources, actinide-bearing alloys, and ceramic waste forms

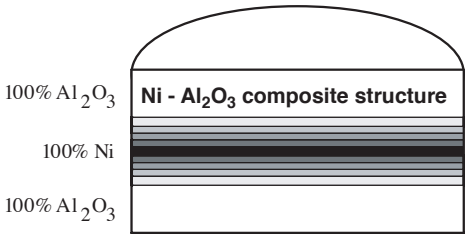
Continued on next page



Bulk sample



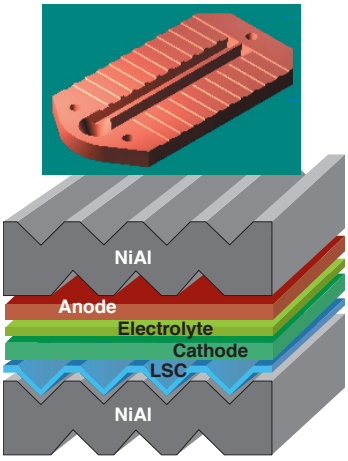
Tensile specimen



Dissimilar materials, e.g., metals and ceramics, cannot be joined. But functionally graded materials, such as this Ni-Al_2O_3 sample, have the best properties of both base materials.

Science
INL
Idaho National Laboratory

Illustration of bipolar plate configuration for solid oxide fuel cell (SOFC).



Exploded schematic view showing layers of a single cell SOFC.

For more information

Richard N. Wright, Ph.D.
(208) 526-6127
Richard.Wright@inl.gov

Douglas C. Crawford, Ph.D.
(208) 533-7456
Douglas.Crawford@inl.gov

www.inl.gov/env-energyscience/materials

INL is a U.S. Department of Energy national laboratory operated by Battelle Energy Alliance

Continued from front

- "Nanoscale Metal Hydride Synthesis and Characterization," Defense Threat Reduction Agency, Advanced Energetics Program.
- Solid oxide fuel cell (SOFC) development.
- Electrophoretic deposition of continuous metal-ceramic graded structures.
- DTRA Advanced Energetcs Program, "Nanoscale Metal Hydride Synthesis and Characterization."
- Fabrication and analysis of rapidly solidified aluminum alloy strip.
- Development of advanced tooling alloys and the fabrication of DTRA Advanced molds and dies from these alloys.
- Processing and testing of metal-encapsulated ceramic armor systems.

Collaborations

- Westinghouse and Pennsylvania State University, corrosion of zircaloy cladding
- Texas A&M University, development of corrosion resistant, high thermal conductivity, inert fuel matrices
- University of California-Davis, Colorado School of Mines, Alcoa, Pechiney Rolled Products, Inductotherm Corp., and Metals Technology Inc.: "Spray Rolling Aluminum Strip."
- University of California-Davis, RSP Tooling LLC, Glass Manufacturing Industry Council, and General Aluminum Manufacturing, Inc.: "Development and Demonstration of Advanced Tooling Alloys For Molds and Dies."
- Tank Automotive Armament Command (TACOM): "Encapsulated Ceramic Armor Systems Processed via Spray Forming."
- P. I. Peter Kong - PPG Industries CRADA: "Synthesis of Nano Particles in a Modular Arc Reactor"
- P. I. Peter Kong - PPG/INL DRAPA Project: "Plasma Synthesis of Nano Boron Carbide Powder."

Publications

"Dual Phase Magnesia-Zirconia Ceramics with Strength Retention at Elevated Temperature," T.C. Yuan, G.V. Srinivasan, J.F. Jue and A.V. Virkar, *Journal of Materials Science*, Vol. 24, p. 3855, 1989.

"Fabrication, Microstructural Characterization and Mechanical Properties of Polycrystalline t'-Zirconia," J.F. Jue and A.V. Virkar, *Journal of the American Ceramic Society*, Vol. 73, p. 3650, 1990.

"Synthesis and Characterization of Gadolinium Phosphate Neutron Absorber," P.A. Lessing and A.W. Erickson, *Journal of the European Ceramic Society*, Vol. 23, p. 3049, 2003.

"Electrophoretic Deposition Applied to Thick Metal-Ceramic Coatings," W.E. Windes, J. Zimmerman, and I.E. Reimanis, *Surface and Coatings Technology,* Vol. 157, p. 267, 2002.

"Syntesis of Nanocrystalline NASICON-type Thin Film Ceramics", P.A. Lessing and G. Huestis, accepted by the Journal of Ceramic Processing Research.

"Plasma Spray Coatings for SOFC", W.E. Windes and P.A. Lessing, 2002 Fuel Cell Seminar Abstracts, 471-474 (2002); Courtesy Associates, 2025 M. Street. N.W., Suite 800, Wash., D.C. 20036.

"Fabrication Methods of a Leaky SOFCO Design", W.E. Windes and P.A. Lessing, Eighth International Symposium of Solid Oxide Fuel Cells (SOFC VIII), 203rd meeting of the Electrochemical Society, Paris, France, April 27-May 2, 2003. (Peer reviewed.)

"Spray Rolling Aluminum Alloy Strip," Kevin M. McHugh, J.P. Delplanque, S.B. Johnson, E.J. Lavernia, Y. Zhou and Y. Lin, *Mater. Sci. Eng.* A 383(1), 96 (2004).

"The Selection of the Spray Deposition Rate During the Spray Rolling Process," Y.J. Lin, K.M. McHugh, Y. Zhou, and E.J. Lavernia, *Metall. Mater. Trans. A* 35, 3595 (2004).

"The Transient to Steady-State Transition During the Spray Rolling Process," Y.J. Lin, K.M. McHugh, Y. Zhou, and E.J. Lavernia, *Metall. Mater. Trans. A* 35, 3633 (2004).